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Expected and Unexpected Impulses of Monetary Policy on the Interest Pass-Through Mechanism in Asian Countries

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This paper examines the impact of expected and unexpected impulses of monetary policy on the interest pass-through mechanism in nine Asian countries and the United States. It also investigates the asymmetry and rigidity of the pass-though process. The EC-EGARCH-M model is created for analyzing and examining the dynamic adjustment of interest rate and it comprises numerous factors such as the major explanatory power of the error correction term over the conditional mean of cointegration series, impulse of expected and unexpected monetary policy, asymmetric error correction term, asymmetric volatility, structural breaks, and interest risk. The empirical results indicate that, first; the asymmetric cointegration relation exists in the deposit rate of four countries and the lending rate of six countries. Second, a majority of the impacts of expected and unexpected monetary policy are positive, and the effect of unexpected monetary impulse are larger that expected ones. Third, the impacts of hetero-risk of interest rate are significant in certain countries, and the leverage effect exists in six countries. Fourth, most countries have downward rigid adjustments in retail interest rate.

Key Words: Monetary policy expectation; Interest rate pass-through; Asymmetric threshold cointegration; EC-EGARCH-M model.
JEL Classification Numbers: C32, C50, E43, E52.

1. INTRODUCTION

Interest rate pass-through implies that the interest rate in the financial market (e.g., interbank interest rate) will change as the government adjusts the policy interest rate. Thus, banks will transfer the cost of the interest rate change to the banking retail interest rate. Over the previous decade, a large number of empirical studies have been conducted in an attempt to

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estimate the degree of interest rate pass-through in the euro area. In the literature, the terminology "interest rate pass-through" generally has two implications: deposit rate pass-through and lending (or loan) rate pass-through. In addition, owing to the forward-looking expectations for most financial markets, timely adjustments are often made to the retail banking interest rates prior to the change in policy rates.

The interest rate pass-through is an important instrument for the implementation of the monetary policy by a country's central bank, adjusting interest rate, controlling inflation by influencing the retail banking interest rate, or realizing economic growth objectives. The monetary policy has great influence on future output and inflation rate; hence, the change in policy interest rates must bring about sufficient response and adjustment of the monetary policy rates and retail banking interest rates. In this paper, under forward-looking assumptions, the impacts of the monetary policy are divided into two portions—expected and unexpected—in order to examine the interest rate pass-through mechanism.

Cottarelli and Kourelis (1994) studied the interest rate pass-through in various countries using a dynamic lending rate model, while Cottarelli et al. (1995), BIS (1994), and Borio and Fritz (1995) applied this concept to the integration of currencies in the European Union (EU). Sander and Kleimeier (2000) analyzed the short-run adjustment of interest rate pass-through using the error correction model (ECM) (e.g., Mojon, 2000; Heinemann and Sch?ler, 2003; Toolsema et al., 2001). Recently, the asymmetric adjustment mechanism has been described (e.g. Sander and Kleimeier, 2000, 2002; De Bondt, 2002; De Bondt et al., 2002), and the research method includes nonlinear models such as Tong (1983), Scholnick (1996, 1999), Balke and Fomby (1997), Enders and Granger (1998), Baum and Karasulu (1998), and Enders and Siklos (2001).

Next, we consider the prediction of monetary policy actions. Sellon (2002) investigated the mortgage rates in the United States and found that it was possible to predict monetary policy actions. Mortgage and market interest rates increase partially when the central bank tightens monetary policy and decrease when the central bank loosens monetary policy. Thus, in cases where the retail banking interest rates make an expected response, the estimated short-run and middle-run pass-through multipliers may not fully reflect the interest rate pass-through process and validate this mechanism adequately. This is because the expectation of the central bank's policy interest rate has an immediate influence on the adjustment of interest rate pass-through, while reflecting the stickiness of banks in response to the central bank's interest rate changes.

Kleimeier and Sander (2006) examined EU countries and incorporated the anticipation of monetary policy into interest rate pass-through issues, and classified monetary policy impulses (MP) into two portions:$MP =$

$MPU + MPE$, where MPU and MPE indicate expected and unexpected monetary policy rate impulses, respectively. This tests the influence of MPE and MPU on interest rate pass-through in countries in the EU, where the monetary policy rate (MP) is EURIBOR (European interbank offered rate) 1-month fixed deposit interest rate, and MPE is the 1-month future contract interest rate. According to the unit root test, MP and MPE are represented by the $I(1)$ series and MPU is represented by the $I(0)$ series. The empirical results indicate that the expected and unexpected monetary policy rates have different impulse multipliers on the retail interest rate; when the change in monetary policy rate is expected, the adjustment of the lending rate pass-through becomes faster and the deposit interest rate becomes rigid. Kleimeier and Sander (2006) made the following conclusions in this regard. (1) Retail banking interest rates exhibit stickiness in adjustment, namely, the adjustment ratio of retail interest rate to monetary policy rate is not 1:1; hence, the short- and middle-run multipliers are far lower than 1.[1] (2) The interbank deposit and lending rate pass-through differ from each other; (3) Asymmetrical adjustment may exist in the interest rate mechanism, and the adjustment mode is not consistent.[2] (4) There are different conclusions with regard

[1] By interest pass-through, we mean the extent to which a change in the policy rate is passed on to retail interest rates. The rigidity (stickiness) in interest rate adjustments implies that a shift in the policy rate has not been fully passed on to retail rates. Generally speaking, interest-rate stickiness arises from (a) adjustment costs of changing loan rates and (b) overlapping multiperiod contracts. As to item (a), a number of theoretical works explain the causes of interest rate stickiness. Actually, bank-rate stickiness has been recognized and discussed since the early 1990s. Some of the reasons for such bank-rate rigidity are the following: the presence of a highly regulated or less-competitive financial sector (Hannan and Berger, 1991, Neumark and Sharpe, 1992), administrative/menu costs for changing loan rates (Mester and Saunders, 1991), and customer's costs for changing banks (Neumark and Sharpe, 1992). On the other hand, monetary policy literature has almost ignored multi-period interest contracts. This seems rather surprising given the fact that the role of multi-period price and wage contracts has been widely discussed thus far (e.g., CityTaylor, 1980; Fuhrer and placeCityMoore, 1995; Chari et al., 2000). In the real world, a large part of bank lending is based on long-term contracts, such as price and wage contracts.

[2] Asymmetric adjustments imply that bank retail rates exhibit an asymmetric relationship or a non-linear phenomenon with the influence of asymmetric information or business cycles on the adjustments of long-run equilibrium conditions. In essence, business cycles are economic fluctuations, with varying business conditions resulting in asymmetric responses, as real economic activities reflect the booms and recessions. Therefore, the relationship between macroeconomic variables is also asymmetric (Henry et al., 2004). In theory, nominal variables are subject to the direct influence of real variables. Therefore, we must consider this asymmetric relationship while looking into the interest rate pass-through mechanism. If the model set-up ignores the non-linear relationship due to this asymmetric relationship between variables and a linear model is used to explore the correlation between variables, the results will be biased. Statistical techniques can validate the existence of such a phenomenon in an objective manner. In principle, one could allow asymmetries in each coefficient of model. Lim (2001) takes this approach

to whether the interest rate is passed through completely in the long run; according to previous literatures, the short-run lending rate is close to a complete pass-through; (5) Previous literatures suggested that the interest rate pass-through mechanisms in EU countries differ from each other; (6) The latest research results indicate that the integration of European currencies leads to rapid and homogeneous interest rate pass-through.

Kleimeier and Sander (2006) indicated that the factors responsible for different empirical results include the following: (1) selection of exogenous money market rates, (2) length of research, (3) presence of structural change, and (4) research methods applied. All these factors tend to affect the interest rate pass-through and short-run adjustment; on the other hand, incomplete market competition and influence of credit rationing on interest rate pass-through still remain important issues. At the same time, Kleimeier and Sander (2006) argued that correct or incorrect expectation regarding the government's policy interest rate influences the performance of the monetary policy. Therefore, it is necessary to divide the influence of expected and unexpected monetary policy impulses on interest rate pass-through. The empirical results indicate that when a change in interest rate is expected, the lending market adjusts faster than the deposit market, thereby implying that whether or not the monetary policy is efficiently predicted will affect the homogeneity and adjustment speed of interest rate pass-through.

This paper explores the interest rate pass-through in Asian countries that experienced a financial crisis from 1997 to 2007. In order to prevent excessive flow of domestic and foreign capital from affecting the stability of the domestic financial market, the countries continuously adjusted the financial market rates in response to the changing U.S. Federal Reserve interest rate. Owing to different economic situations, central banks in Asian countries adopted different measures with respect to changing and adjusting their retail banking interest rates. On the other hand, the competition and integration among various Asian countries is growing as Asia has experienced financial turmoil in recent years, and interbank collusion and competition have brought about rapid changes in the financial market. Hence, it may be inadequate to only consider the influences of an expected monetary policy for understanding the dynamic adjustment of

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and investigates asymmetry depending on the sign of interest rate changes. However, different theoretical models predict different factors that generate non-linearity. This suggests going beyond the traditional models that capture only sign asymmetries, by allowing multiple drivers of non-linearity. From an econometric point of view, then, parsimony dictates that non-linearity be restricted to a limited number of coefficients. Because of its close correspondence to theoretical models, we focus on the adjustment coefficient. This is similar to most of the existing empirical studies, e.g., Neumark and Sharpe (1992), Frost and Bowden (1999), Hofmann and Mizen (2004), and Sander and Kleimeier (2004).

interest rates. Under such circumstances, state governments, banks, and investors possibly have different predictions on the future variation of interest rate, the influences of financial market information, and governmental regulation on the outflow or inflow of capital.

In keeping with Sellon (2002) and Kleimeier and Sander (2006), who studied the influence of expected and unexpected monetary policy impulses on the interest rate pass-through, the main aspects of this paper are as follows: (1) whether an asymmetric cointegration relationship exists between retail interest and money market interest rates, that is, whether the interest rate pass-through mechanism has an asymmetric adjustment mechanism; (2) whether there is heteroskedasticity in interest rates changes; (3) whether the expected monetary policy shocks on retail interest rates adjustments are different from the unexpected shocks; (4) whether the error-correction term deviates from the adjustment characteristics, thereby verifying if the deviation adjustment of short-run retail interest rates possesses asymmetry and rigidity; (5) detecting the impact of heterogeneous interest rate risk on retail interest rates; (6) whether a leverage effect exists in the conditional variance.

Most existing researches in this field use the linear (or symmetric) model for discussing the interest rate pass-through mechanism. In such a setting, without the existence of this mechanism the central bank cannot effectively utilize the policy interest rate or short-term money market rate for implementing monetary policy. The linear model does not take into account that nonlinear factors, such as the market structure or asymmetry of market information, may also lead to the existence of interest rate pass-through. Therefore, the linear model is biased to the non-existence of the interest rate pass-through. Moreover, the traditional linear cointegration model and ECM do not consider the asymmetric adjustment of interest rates; thus, the estimation results tend to reject the pass-through mechanism among interest rates. In addition, the uncertainty associated with interest rate volatility is becoming greater with the increased evolvement of financial commodities. The traditional error correction model focuses on the first moment relationship but ignores the effect from the interest rate risk (the second moment); thus, the model may not be able to accurately explain the adjustment process of the interest rate in the short-run.

On account of the abovementioned problems with the linear model, this study employs the Error-Correction EGARCH in Mean (EC-EGARCH-M) model for discussing the interest rate pass-through mechanism. The testing procedure is as follows. First, we use the asymmetric threshold auto-regression (TAR) model and the momentum threshold auto-regression (MTAR) model proposed by Enders and Siklos (2001) for investigating the interest rate pass-through mechanism from the money market rates to retail interest rates; moreover, the existence of asymmetry in this mechanism is also investigated. Second, we put the exogenous volatility of interest rates, MPE and MPU, and the error-correction term into the conditional mean equation in order to establish the EC-EGARCH-M model.

The remainder of this paper is organized as follows. Section 2 introduces the literature. Section 3 constructs the research methods and models. Section 4 clarifies the empirical results. Section 5 explains the economic meanings and implications. Section 6 presents the conclusion.

2. LITERATURE REVIEW

Interest rates are the prices of funds; therefore, interest rate should be determined by the demand and supply in the fund market. Factors like the general price level, money supply, income, and exchange rate all influence the interest rate level. As indicated by Bernanke (1990), money supply could affect interest rates in four ways: the income effect, the price effect, the liquidity effect, and the expectations of inflation. These four channels are also related to business cycles. Bernanke (1990) analyzes the effectiveness of the monetary policy and predicts business cycles using the interest rate and interest rate spread. The author argues that monetary policy determines the growth rate of money supply. This relationship combined with the interaction between the long- and short-term interest rates has an impact on investment and other economic activities. Since money market rates are very short-term interest rates, changes in these rates would cause structure adjustments in the long- and short-term interest rates. However, the direction and magnitude of these adjustments depend on the existence of adjustment rigidity.

According to Toolsema et al. (2002), in order to analyze the effects of monetary policy on the pass-through to retail interest rates, one could attempt to answer one of the following three questions: Why does the rigidity of interest rate adjustment exist? How similar is the rigidity among countries? What is the relationship among the rigidity, monetary policy, financial system structure, and financial structures of financial intermediaries? From a theoretical viewpoint, Lowe and Rohling (1992) appear to answer one of the questions proposed by Toolsema et al. (2002). Lowe and Rohling (1992) argue that the factors causing the existence of the rigidity of interest rate adjustment are the agency cost, adjustment cost, switching cost, and risk sharing. Most research on interest rate rigidity focuses on the Economic and Monetary Union (EMU) member countries. Sander and Kleimeier (2002) find that in EMU countries, the short- and long-run pass-through parameters differ with sample periods. Mojon (2000) uses data from 1979 to 1988 and 1988 to 1998 and finds that the pass-through margins in these two time periods are less than the average margin of countries that neighbor EMU countries. Using the Johansen cointegration test for examining the pass-through mechanism of France, Germany, Italy, and Spain from 1984 to 1998, Hofmann (2002) finds that in the long-run, changes in the money market rate are completely passed on to retail interest rates. Moreover, in the short-run, the lending rate has a lower adjustment speed.

Numerous studies believe that the reason for the rigidity of the retail interest rate adjustment is that the retail interest rate adjustment process is asymmetric. According to Hannan and Berger (1991) and Neumark and Sharpe (1992), there are two sources for this asymmetry: collusive pricing arrangements and adverse customer reaction. The former indicates that any pricing arrangement other than the collusive pricing arrangement implies the incurrence of an extra cost. For example, commercial banks occasionally offer a promotion of providing a higher deposit interest rate or a lower lending rate in order to attract more customers. Doing this may raise operational costs and reduce profits of commercial banks. Collusive pricing arrangements imply rigidity in lifting the deposit interest rate and reducing lending rate. The adverse customer reaction hypothesis states that by reducing the deposit interest rate or increasing the lending rate for gaining greater profits, commercial banks may face the risk of losing customers, which in turn will lower the banks' profits. Therefore, adverse customer reaction implies rigidity in reducing the deposit interest rate and lifting the lending rate.

Certain studies focus on a cross-country comparison or single-country research of the pass-through effect. Scholnick (1996) finds that the collusive pricing arrangement hypothesis could not be rejected in Malaysia and Singapore. Empirical results in Enders and Granger (1998) indicate that the asymmetric error correction model could explain the long-run equilibrium relation between the long- and short-term interest rates in the United States. Frost and Bowden (1999) find an asymmetric relation between the mortgages and certificate deposit interest rates in New Zealand. Bohl and Siklos (2001) find that an asymmetric cointegration relation exists between the long- and short-term interest rates in Germany. The empirical results of Lim (2001) indicate that upward-rigidity adjustment exists in both the deposit and lending interest rates in Australia.[3]

With the assumption that the interest rate adjustment process is smooth, Iregui et al. (2002) employ the smooth transition autoregressive model for investigating the behaviors of the deposit and lending rates in Columbia and Mexico in periods when the interest rate differential is greater than the normal value (a period when the banking system does not function

[3]Downward rigidity implies that, when retail interest rates are asymmetric, the rate of increase in interest rates is greater than the rate of decrease in the shift from short-run disequilibrium to long-run equilibrium. With upward rigidity, the rate of decrease is greater than the rate of increase. Many studies believe that retail interest rate adjustments are rigid because the adjustment process is asymmetric.

normally or a financial crisis period) and when the interest rate differential is smaller than the normal value (a period when competition among commercial banks is rigorous or a period when the banking system functions normally). The authors assume that complete pass-through exists between the spread of the deposit-overnight-call and lending-overnight-call rates. The empirical results indicate that, in contrast to the results in Lim (2001), downward-rigidity adjustment exists in both the deposit and lending rates. This result does not support the collusive pricing arrangement and adverse customer reaction hypotheses.

After the integration of currencies in certain European countries, the issue of the interest rate pass-through mechanism has attracted a lot of attention in the literature. Sander and Kleimeier (2002) use EU countries as their sample and find that the adjustment process of the retail interest rate is related to that of the monetary market rate. The authors assume an imperfect competitive market and profit-maximizing commercial banks and find that the lower demand and supply elasticity of funds causes the asymmetric adjustment of the interest rate. Empirical results indicate that there is downward-rigidity adjustment in the lending rate and upward-rigidity adjustment in the deposit interest rate among the EU countries, which supports the collusive pricing arrangement hypothesis.

Sander and Kleimeier (2004) find that the existence of the menu cost enhances the motivation of commercial banks to pass through the associated costs to customers, and this motivation is reinforced when there is change in the money market rate. This behavior of the commercial banks enlarges the interest rate adjustment margin to become greater than a given threshold value. In this case, the conditions for a perfect competitive market do not hold and multiple pass-through mechanisms exist so that the complete and incomplete pass-through mechanisms could exist at the same time.

Using monthly data from Hungary between 1997 and 2004 and the asymmetric error-correction model, Horváth et al. (2004) investigated the retail interest rate relationship and adjustment speed in the Hungarian money market. The authors found that the speed of interest rate adjustment is impacted by the long-run error between the money market and retail interest rates. Compared with the competition among commercial banks in other European countries, competition in Hungary is more rigorous, which leads to a greater adjustment speed of the lending rate. In the meantime, the lower demand for bank loans, lower interest rate elasticity, and higher risk premium all contribute to the rigidity of the lending rate.

In the study of asset pricing, researchers have found that price fluctuation in financial assets is characterized by the cluster phenomena. Engle *et al.* (1990) indicate that market information affects the fluctuation of the conditional variance of the price. Nelson (1991) argues that different market information has different effects on conditional variance. We establish an EGARCH model in order to explain the phenomenon of asymmetric adjustment margins. Traditionally, the EGARCH model is used to explain the cluster phenomena of the fluctuations of stock price or exchange rate. Engle and Yoo (1987) and Lee (1994) argue that the error-correction term is a crucial factor for explaining the conditional mean of cointegration variables. Lee (1994) puts the error-correction term in the GARCH model and establishes the EC-GARCH model. In the present paper, we expand this model by adding the error-correction term in the mean equation in order to construct the EC-EGARCH-M model.

3. RESEARCH PROCEDURE AND METHODLOGY

The testing procedure is described as follows. First, we use the TAR and MTAR models proposed by Enders and Siklos (2001) in order to investigate the interest rate pass-through mechanism from the money market rates to retail interest rates, as well as the existence of the asymmetry of this mechanism. Second, we put the exogenous volatility of the interest rates, MPE and MPU impulses, and the error-correction term into the conditional mean equation in order to establish the EC-EGARCH-M model (see appendix A for detail illustrate).

With regard to MPE and MPU impulses, it is assumed that the expected impulses belong to the adaptive expectation category, as described by Kleimeier and Sander (2006). Thus, MPE indicates previous MP, while $MPU = MP - \psi MPE$, which are residuals of MP first-order autoregression. Thus, when MP and MPE are represented by $I(1)$ sequences, MPU is represented by an $I(0)$ sequence.[4]

In addition, when there is cointegration and the adjustment of the asymmetric error-correction model cannot produce a white noise residual, we created the asymmetric EC-EGARCH(1,1)-M model:

$$\begin{aligned}\Delta R_t &= a_0 + \sum_{i=1}^{p} a_i \Delta R_{t-i} + \sum_{j=1}^{q} b_j \Delta \nu_{t-j} + m_E \Delta MPE_t \qquad (1)\\ &+ m_U \Delta MPU_t + s \log \sigma_t^2 + \eta_1 M_t \hat{e}_{t-1} + \eta_2 (1 - M_t) \hat{e}_{t-1} + \nu_t \\ &\nu_t | \Omega_{t-1} \sim N(0, \sigma_t^2)\end{aligned}$$

[4]This paper estimated $AR(p)$, $MA(q)$, and $ARMA(p,q)$ models; out-sample prediction indicated the optimal result of $AR(1)$. Thus, $AR(1)$ was used to estimate MPE and MPU impulses.

$$\log\sigma_t^2 - \omega = \beta(\log\sigma_{t-1}^2 - \omega) + \alpha\left\{\left|\frac{\nu_{t-1}}{\sigma_{t-1}}\right| - E\left|\frac{\nu_{t-1}}{\sigma_{t-1}}\right| + \gamma\frac{\nu_{t-1}}{\sigma_{t-1}}\right\} + \sum_{k=1}^{n_k} d_k Dum_{k,t} \quad (2)$$

In Eq.(1), the error-correction term ($\hat{e}_{t-1}$) is added in order to prevent the possibility of spurious regression by overlooking the long-run cointegration relationship. ($\hat{e}_{t-1}$ computational procedures can refer appendix A). The long-run equation of retail banking interest rates and money market rate is as follows:

$$R_t = \theta_0 + \theta_1 MP_t + e_t \quad (3)$$

In the above equation, R_t indicates the retail interest rates, MP_t is the monetary policy rate, and e_t is long-run error. θ_0 is the fixed mark-up of the retail interest rate, θ_1 is a pass-through parameter or long-run multiplier. If $\theta_1 < 1$, it indicates partial pass-through; if $\theta_1 = 1$, it represents complete pass-through.

In Eq. (1), i.e., the mean equation, parameters m_E and m_U are the impulse parameters of MPE and MPU, respectively, wherein a positive value implies a positive impulse effect and vice versa. If $m_E > m_U$, it indicates that the MPE are greater than MPU; otherwise, MPE are smaller than MPU. Parameter η_i is the adjustment speed of error-correction terms. If the adjustment coefficient is negative, the short-run disequilibrium may be adjusted into a long-run equilibrium through the ECM process, namely, a stable adjustment. If the adjustment coefficient is positive, the short-run disequilibrium cannot be adjusted into a long-run equilibrium through the ECM process, namely, a divergence or unstable adjustment. Moreover, we add the effect of the interest rate volatility (the logarithm of conditional variance, $\log\sigma_t^2$) in the interest rate to the mean equation. Hence, when parameter s is significantly positive, it indicates that the volatility of interest rates would enhance the fluctuation margin of the interest rates, and vice versa. In order to correct the autocorrelation problem, we add a one-period lag asymmetric error-correction term, a delay autoregressive term $AR(p)$, and a moving average term $MA(q)$. We estimate the asymmetric EC-EGARCH(1, 1)-M model using the maximum likelihood method. The log likelihood function is as follows:

$$\log L = -(T/2)\log(2\pi) - (1/2)\sum_{t=1}^{T}\log(\sigma_t^2) - (1/2)\sum_{t=1}^{T}(v_t^2/\sigma_t^2) \quad (4)$$

Equation (1) could be used to examine the adjustment rigidity of the retail interest rate. When $\Delta\,\widehat{e}_{t-1} \geq \hat{\tau}$, it indicates that after the adjustment of the money market rates, the change in the retail interest rates is greater than the change of the long-run error in the money market rate. Therefore, the adjustment margins of retail interest rates must be reduced. When $\Delta\,\widehat{e}_{t-1} < \hat{\tau}$, it indicates that the change in the retail interest rates is smaller than the change in the long-run error in the money market rate.[5] Therefore, the adjustment margins of the retail interest rates must be enlarged. Through the error-correction terms $M_t\,\widehat{e}_{t-1}$ and $(1 - M_t)\,\widehat{e}_{t-1}$, the margins of the retail interest rates could adjust to suitable sizes. Parameters η_1 and η_2 are the adjustment speeds of the positive and negative error-correction terms, respectively. If η_1 does not equal η_2, then adjustment rigidity in the retail interest rate exists. If $|\eta_1| > |\eta_2|$, then upward-rigidity adjustment exists in retail interest rates; otherwise, downward-rigidity adjustment exists in retail interest rates.

Equation (2) is the conditional variance equation. If γ is significant and differs from zero, then an asymmetric effect exists in the conditional variance. If γ is significant and smaller than zero, then leverage effect exists in the conditional variance.[6] n_k is the number of structural breaks, $Dum_{k,t}$ represent the dummy variables that are 0 with a pre-structural break and 1 with a post-structural break (including the beginning point of a structural break). We adopt the iterated cumulative sums of squares (ICSS) algorithm of Inclán and Tiao (1994) in order to detect structural breaks.

[5]The threshold value $\widehat{\tau}$ computational procedures can refer appendix A.

[6]We consider the impact of each country's expansionary monetary policy (retail interest rates drop) message relative to the deflationary monetary policy (retail interest rates rising) message on interest rate risk (σ^2) in equation 2, when γ is negative and significant. This implies the risk impulse of retail interest rates—that a drop in rates is greater than a rise, because of the leverage effect.

In addition, if the cointegration relation is symmetric, then the error-correction term in equation (1) must be modified into symmetric form:

$$\begin{aligned}\Delta R_t &= a_0 + \sum_{i=1}^{p} a_i \Delta R_{t-i} + \sum_{j=1}^{q} b_j \Delta \nu_{t-j} + m_E \Delta MPE_t \\ &+ m_U \Delta MPU_t + s \log \sigma_t^2 + \eta_1 \hat{e}_{t-1} + \nu_t \end{aligned} \tag{5}$$

If there is no such cointegration relation, then we will discard the error-correction term in equation (2):

$$\begin{aligned}\Delta R_t &= a_0 + \sum_{i=1}^{p} a_i \Delta R_{t-i} + \sum_{j=1}^{q} b_j \Delta \nu_{t-j} + m_E \Delta MPE_t \\ &+ m_U \Delta MPU_t + s \log \sigma_t^2 + \nu_t \end{aligned} \tag{6}$$

In the absence of a cointegration relationship, the long-term multiplier equation is estimated as $\theta_1 = \dfrac{m_E + m_U}{1 - \sum_{i=1}^{p} a_i}$ in equation (6). The specification of the EC-EGARCH(1,1)-M model is crucial to our analyses. We employ the sign bias (SB) test, the negative size bias (NSB) test, the positive size bias (PSB) test, and the Joint test of Engle and Ng (1993) in order to examine whether the asymmetric effect exists in the standardized residuals of the model.

4. EMPIRICAL RESULTS

The monthly data in this paper encompass the financial markets of the United States and the following nine Asian countries: Hong Kong, Indonesia, Japan, South Korea, Malaysia, Philippines, Singapore, Thailand, and Taiwan. The variable data include the deposit interest rate (D_{it}), lending rate (L_{it}), and money market rate (MP_{it}), whose definitions are provided in Table 1. The samples from Hong Kong were collected between Jan. 1994 and Sep. 2007, and those from other countries were collected between Sep. 1986 and Sep. 2007. The data from Taiwan were obtained from the macroeconomic database of Taiwan Economic Journal (TEJ), and those of the other nine countries were obtained from the statistics database of International Financial Statistics (IFS).

In order to check the stationarity of variables, Table 2 lists the Augmented Dickey Fuller (ADF) unit-root test results of the level and first-differenced values of the variables. The optimum lag period is determined by the AIC criterion. It is obvious that at the 5% significant level, except for $I(0)$ in Indonesia, the interest rates of all the sample countries are $I(1)$ series.

TABLE 1.

Definitions of the Variables

Country	Code	Deposit Interest Rate	Code	Lending Rate	Code	Money Market Rate	Code
Hong Kong	HK	DEPOSIT RATE	D_HK	LENDING RATE (PRIME RATE)	L_HK	MONEY MARKET RATE (FEDERAL FUNDS)	M_HK
Indonesia	IND	DEPOSIT RATE	D_IND	LENDING RATE (PRIME RATE)	L_IND	MONEY MARKET RATE (FEDERAL FUNDS)	M_IND
Japan	JAP	DEPOSIT RATE	D_JAP	LENDING RATE (PRIME RATE)	L_JAP	MONEY MARKET RATE (FEDERAL FUNDS)	M_JAP
Korea	KOA	DEPOSIT RATE	D_KOA	LENDING RATE (PRIME RATE)	L _KOA	MONEY MARKET RATE (FEDERAL FUNDS)	M_KOA
Malaysia	MAL	DEPOSIT RATE	D_MAL	LENDING RATE (PRIME RATE)	L_MAL	MONEY MARKET RATE (FEDERAL FUNDS)	M_MAL
The Philippines	PHI	DEPOSIT RATE	D_PHI	LENDING RATE (PRIME RATE)	L_PHI	DISCOUNT RATE(END OF PERIOD)	M_PHI
Singapore	SIG	DEPOSIT RATE	D_SIG	LENDING RATE (PRIME RATE)	L_SIG	MONEY MARKET RATE (FEDERAL FUNDS)	M_SIG
Thailand	THA	DEPOSIT RATE	D_THA	LENDING RATE (PRIME RATE)	L_THA	MONEY MARKET RATE (FEDERAL FUNDS)	M_THA
Taiwan	TWN	Weighted Average Interest Rates on Deposits	D_TWN	Weighted Average Interest Rates on Loans	L_TWN	Interbank Money Market Interest Rates - Overnight	M_TWN
U.S.	US	OVERNIGHT US $ DEPOSITS, LONDON OFFER	D_US	LENDING RATE (PRIME RATE)	L_US	MONEY MARKET RATE (FEDERAL FUNDS)	M _US

Note: Variable D_i denotes the deposit interest rate of country i; variable L_i indicates the lending rate of country i; variable M_i represents the money market rate of country i.

TABLE 2.

The ADF Unit-Root Test

Country	HK	IND	JAP	KOA	MAL	PHI	SIG	THA	TWN	US
Level										
D_i	−1.876(8)	−2.958**(3)	−1.447(7)	−1.571(8)	−1.758(11)	−1.597(0)	−1.583(1)	−1.104(1)	−0.617(12)	−1.947(3)
L_i	−2.514(7)	−2.586*(10)	−1.384(6)	−1.740(1)	−1.728(8)	−1.403(12)	−2.519(1)	−1.063(3)	−0.526(0)	−2.107(3)
M_i	−1.986(2)	−3.359**(8)	−1.493(6)	−1.493(6)	−2.006(4)	−1.614*(10)	−2.232(2)	−1.922(6)	−0.940(10)	−2.177(3)
First-differenced value										
D_i	−3.510***(6)	−7.276***(1)	−3.978***(6)	−5.306***(7)	−5.181***(6)	−10.60***(1)	−8.797***(0)	−12.76***(0)	−5.661***(3)	−6.536***(2)
L_i	−5.423***(2)	−4.434***(13)	−2.706*(5)	−10.63***(0)	−4.417***(7)	−4.347***(11)	−9.102***(0)	−11.36***(2)	−11.87***(3)	−5.133***(2)
M_i	−10.47***(2)	−14.12***(1)	−3.270**(5)	−3.270**(5)	−8.402***(3)	−8.360***(9)	−13.51***(1)	−7.788***(5)	−6.701***(9)	−3.852***(5)

Note: We put the constant term in the ADF equation. Values in the parentheses are the optimum delay difference periods that is determined by applying the AIC criterion; the maximum is 12. *** indicates the significance at 1% level; for the critical values, please refer to MacKinnon (1996).

TABLE 3.

Estimation of the Long-Run Parameters

Country	HK	IND	JAP	KOA	MAL	PHI	SIG	THA	TWN	US
Deposit rate model										
θ_0	−0.319(0.080)	9.379(0.000)	0.199 (0.000)	3.570(0.000)	0.839(0.017)	2.938 (0.000)	0.329(0.012)	2.408(0.000)	0.498 (0.000)	0.089(0.626)
θ_1	0.864(0.000)	0.477(0.000)	0.488 (0.000)	0.477(0.000)	0.870(0.000)	0.578 (0.000)	0.651(0.000)	0.709(0.000)	0.217 (0.000)	0.993(0.000)
$H_0: \theta_1 = 1$	12.25(0.000)	557.9(0.000)	2487 (0.000)	780.1(0.000)	47.76(0.000)	80.36 (0.000)	90.29(0.000)	98.57(0.000)	497.5 (0.000)	6.214(0.012)
Lending rate model										
θ_0	4.961(0.000)	16.19(0.000)	2.044 (0.000)	5.528(0.000)	5.730(0.000)	7.060 (0.000)	4.990(0.000)	6.666(0.000)	3.001 (0.000)	3.513(0.000)
θ_1	0.616(0.000)	0.272(0.000)	0.743 (0.000)	0.369(0.000)	0.605(0.000)	0.624 (0.000)	0.322(0.000)	0.554(0.000)	0.954 (0.000)	0.834(0.000)
$H_0: \theta_1 = 1$	183.1(0.000)	2529(0.000)	572.7 (0.000)	1018(0.000)	122.1(0.000)	61.73 (0.000)	1259(0.000)	346.0(0.000)	667.0 (0.000)	183.4(0.000)

Note: The long-run equation of the lending rate model is: $R_t = \theta_0 + \theta_1 MP_t + e_t$. We use the Wald test to examine the null hypothesis: $H_0: \theta_1 = 1$. Values in the parentheses are the p-value.

Table 3 lists the estimation results of the long-run parameters of the deposit and lending rate models for all countries. For parameterθ_0, in the deposit interest rate model, a significant markup effect exists in all nine countries, except Hong Kong. In the lending rate model, the significant markup effect exists in all countries. As compared with the markup values between two interest rate models, the values in deposit rates are larger than in lending rates. For parameter θ_1, in the deposit interest rate model, there is incomplete pass-through in all countries. The pass-through ratio almost equals 1 in the United States (0.993) and Taiwan has the lowest value (0.217). In the lending rate model, there is incomplete pass-through in all countries as well. The largest pass-through ratio is found in Taiwan (0.954) and the lowest in Indonesia (0.272). Taiwan is a special case with lower pass-through ratio in deposit rate and a larger ratio in lending rate—the larger interest spread implies that the bank systems in Taiwan are not competitive but oligopolistic. We conduct further investigation in order to test the hypothesis of the complete pass-through ($H_0 : \theta_1 = 1$) in both deposit and lending rates. For all countries, the null hypothesis is rejected, which implies that for all countries, the pass-through is incomplete. Since the retail interest rate pass-through ratios of these countries are less than 1, when the financing costs of the commercial banks increase, they will not pass all the costs to the consumers by raising the retail interest rates.[7]

[7]From a macroeconomic perspective, understanding the behavior of retail interest rates is crucial. According to the traditional interest rate channel of monetary policy transmission, policy rates have a one-for-one effect on interest rates upon which agents base their decisions. Much of the research in the pass-through literature aims to test that assumption, the so-called completeness hypothesis. Another assumption implicit in the money view of policy transmission is that there are no distributional effects across banks. According to the credit view, however, differences in banks' financial structure entail heterogeneities in bank behavior. From a micro-economic perspective, the pass-through sheds light on banks' incentives to change prices of their retail products. Moreover, tracing bank-related differences in pricing policies is crucial in the validation of various theories. Government adjusts policy rates according to business-cycle volatility, which is followed by correction of money market rates among banks (interbank interest rate). Banks should transfer the change in money-market rates to retail rates (including deposit and lending rates). This process is the so-called interest rate pass-through. However, banks are unable to transfer this cost immediately to retail rates because of their contract maturities, financial structure, or operating system. In general, one part of the cost is borne by customers; the other part is passed through markup/markdown on fixed rates. Hence, the pass-through of money-market rates to retail rates is not a 1:1 ratio, and is therefore called non-complete pass-through. Table 3 shows that, even in the long-run, deposit and lending rates will not adjust one to in response to changes in the policy rate. The economic implication that retail interest pass-through is a non-complete mechanism and the impact of the policy rate on the retail rate is not permanent. Therefore, when the lending rate increases by a smaller amount than the increase in the policy rate, it does not imply that the interest increase by the central bank will cause the margin between the retail lending rate and the central bank rate to be lower, permanently. In fact, when the lending rate increases by a smaller amount than the increase in the

Table 4 lists the estimation results using the TAR and MTAR models. In the TAR estimation, for the deposit interest rate, an asymmetric cointegration relationship exists in Hong Kong and Malaysia, and a symmetric cointegration relation exists in Indonesia, Philippines, and the United States. For the lending rate, an asymmetric cointegration relationship is found in Hong Kong, and a symmetric cointegration relation exists in Malaysia and Philippines. In the MTAR estimation, the asymmetric cointegration of the deposit interest rate exists in Hong Kong, Malaysia, Philippines, and Taiwan, and that of the lending rate exists in Hong Kong, Korea, Philippines, Singapore, Thailand, and the United States. The deposit rates of Indonesia and the United States and the lending rate in Malaysia possess a symmetric cointegration relation. The results indicate that asymmetric cointegration relations are usually caused by residual momentum, and this information cannot be excluded.

Table 5 lists the basic statistics of the first-differenced interest rates. The normal distribution hypothesis is rejected by other statistics, such as the skewness, kurtosis, and the Jarque-Bera statistics. We believe the reason for the rejection of the normal distribution hypothesis is that even though we first-differenced the interest rates, the correlation continue to exist among interest rates. On account of this, we further examine the Ljung-Box (LB) statistic of interest rate fluctuations and the LB statistics of squared interest rate fluctuations. Table 5 presents the results. Except for the deposit interest rate in the Philippines, all other interest rates are auto-correlated in the level value or in the squares. This indicates that interest rate volatility has the characteristic of heteroskedastic variance. Since the traditional ECM model cannot deal with the heteroskedastic variance problem, we use the EC-EGARCH model under the MTAR structure in order to analyze the interest rate adjustment in the short-run. Based on the test results in Table 4 and the basic statistics in Table 5, we use the asymmetric EC-EGARCH (1, 1)-M model for examining the deposit interest rates in Hong Kong, Malaysia, the Philippines, and Taiwan, and the lending rates in Hong Kong, Korea, the Philippines, Singapore, Thailand, and the United States. For the lending rate in Malaysia and the deposit interest rates in Indonesia and the United States, we use the symmetric EC-EGARCH (1, 1)-M model. For countries that do not possess a cointegration relation, we use the EGARCH (1, 1)-M model for estimation.

policy rate, the margin would be lower. At this point, the bank will take advantage of the markup pricing to cover the cost of possible. Mojon (2000), Toolsema et al. (2002), Angeloni et al. (2003), Gambacorta (2004), and Kleimeier and Sander (2006) give the same findings.

TABLE 4.

The TAR and MTAR Cointegration Tests

		TAR cointegration test				MTAR cointegration test			
Country	Model	Delay periods	Φ	F	τ	Delay periods	Φ	F	τ
HK	D_HK	1	14.49***	5.622(0.018)**	−2.063	1	17.87***	11.54(0.002)***	−0.888
	L_HK	1	26.51***	26.50(0.000)**	1.186	1	19.78***	11.36(0.000)***	−0.308
IND	D_IND	6	7.973**	2.064(0.152)	−3.705	7	9.007**	0.305 (0.581)	−1.140
	L_IND	7	3.848	0.003(0.951)	−2.890	7	5.438	3.084 (0.080)	−0.617
JAP	D_JAP	1	5.796	2.773(0.097)*	0.409	1	5.735	2.655(0.104)**	−0.064
	L_JAP	6	2.262	1.324(0.250)	0.360	6	2.034	0.876 (0.350)	−0.017
KOA	D_KOA	1	4.310	0.547(0.460)	−1.236	1	4.599	1.106 (0.293)	−0.286
	L_KOA	6	2.892	0.221(0.638)	−1.169	3	7.465*	11.26(0.000)***	0.017
MAL	D_MAL	4	16.52***	3.037(0.082)*	−0.489	4	19.08***	7.610(0.006)***	−0.052
	L_MAL	3	7.453*	0.157(0.061)	0.180	3	7.658**	0.543 (0.461)	−0.184
PHI	D_PHI	2	6.572*	2.260(0.133)	−2.269	2	12.13***	12.92(0.000)**	1.009
	L_PHI	2	6.299*	1.827(0.177)	−2.771	2	15.46***	19.38(0.000)***	1.482
SIG	D_SIG	2	2.642	0.445(0.504)	0.974	2	3.905	2.923(0.088)*	−0.240
	L_SIG	1	5.865	0.043(0.834)	−0.515	1	8.133**	4.375(0.037)**	−0.101
TWN	D_TWN	8	1.770	0.733(0.392)	0.237	8	6.827*	10.72(0.001)***	0.081
	L_TWN	8	3.228	0.258(0.611)	−0.649	8	3.181	0.167 (0.682)	−0.437
THA	D_THA	6	2.894	0.177(0.673)	−2.139	6	4.115	2.564 (0.110)	−0.530
	L_THA	6	2.193	0.008(0.926)	1.224	6	7.396*	6.702(0.010)**	−0.272
US	D_US	4	7.853**	1.594(0.207)	−0.056	4	7.120*	0.208 (0.648)	−0.059
	L_US	5	4.848	0.707(0.401)	−0.356	3	10.76***	5.187(0.023)**	0.066

Note: This table used the Φ statistic that employed by Enders and Siklos (2001) to examine the existence of the asymmetric cointegration relation. The null hypothesis is $\rho_1 = \rho_2 = 0$ and statistic Φ follows the F-distribution. A rejection of the null hypothesis indicates that the cointegration relation exists. In this case, one could test the existence of the symmetric adjustment with the null hypothesis specified as $\rho_1 = \rho_2$. If the null hypothesis of symmetric adjustment could not be rejected, this indicates the existence of the symmetric long-run relation suggested by Engle-Granger cointegration. If the null hypothesis ($\rho_1 = \rho_2$) is rejected, this means that there exist the asymmetric long-run cointegration relation among the interest rates. For the critical values of the Φ statistic, please refer to Table 2 of Wane *et al*. (2004), the maximum of the delay period is 15. We choose the optimum lag-periods basing on the requirement that the disturbance follows White noise.

Table 6 lists the estimation results of the EC-EGARCH (1, 1)-M model.[8] We apply the following tests in order to conduct the diagnostic test: the

[8]This article uses the EC-EGARCH-M model because of the following reasons: First, from Table 5, we found that the change of retail rates have the cluster phenomenon. This means that market information would affect the fluctuation of the conditional variance of retail rates. Nelson (1991) argues that different types of market information have different effects on conditional variance, and sets up an EGARCH model to explain the phenomenon of asymmetric adjustment margins. In this study, we first incorporated the retail interest rates into the pass-through model, and used the resulting EGARCH-M to validate the impact of interest rate risk. Second, according to empirical literature, as well as the theory of interest rate, retail interest rates and policy rates must have a

TABLE 5.

The Basic Statistics of the First-Differenced Interest Rate Variable

Deposit rate	D_HK	D_IND	D_JAP	D_KOA	D_MAL	D_PHI	D_SIG	D_THA	D_TWN	D _US
Mean	0.002	−0.031	−0.005	−0.018	−0.016	−0.023	−0.011	−0.027	−0.006	−0.005
Standard deviation	0.405	1.500	0.147	0.399	0.341	1.018	0.182	0.535	0.048	0.254
Skewness coefficient	−0.608	0.637	3.142	1.209	−5.190	0.562	−1.945	−1.370	−5.599	0.038
Kurtosis coefficient	10.77	16.77	36.59	35.68	44.92	6.214	26.52	14.56	54.24	15.34
J-B statistic	423.1***	2010***	12262***	11276***	19589***	121.8***	5971***	1484***	28919***	1402***
$LB(12)$	35.95***	101.49***	26.85***	134.9***	53.14***	10.79	122.7***	26.41***	4.37***	77.12***
$LB^2(12)$	86.45***	121.71***	16.56	68.01***	9.740	7.837	104 − 7***	28.67**	18.52	40.77***
Lending rate	L_HK	L_IND	L_JAP	L_KOA	L_MAL	L_PHI	L_SIG	L_THA	L_TWN	L _US
Mean	0.006	−0.031	−0.015	−0.013	−0.024	−0.029	−0.004	−0.020	−0.034	0.002
Standard deviation	0.210	0.710	0.068	0.367	0.202	1.145	0.136	0.942	0.265	0.196
Skewness coefficient	0.823	3.488	0.448	3.765	−3.439	−0.175	−0.469	0.020	−1.323	−0.592
Kurtosis coefficient	6.868	35.68	7.650	35.34	42.41	5.484	22.76	101.3	8.260	5.577
J-B statistic	120.8***	11726***	235.5***	11580***	16808***	66.12***	4110***	10158***	228.3***	84.51***
$LB(12)$	65.56***	110.9***	868.7***	71.94***	119.6***	32.56***	104.8***	44.13***	12.94	246.01***
$LB^2(12)$	25.83**	20.65*	270.7***	31.48***	26.41***	31.19***	72.07***	62.45***	43.66***	48.79***

Note: Variable D_i indicates the deposit interest rate of country i; variable L_i denotes the lending rate of country i; variable. J-B statistic shows the statistic value of the Jarque-Bera normality test. $LB(12)$ is the Ljung-Box statistic of the 12-day delay, and $LB2(12)$ is the Ljung-Box statistic of the squared 12-day delay asset returns. ***, **, and * indicate the significances at 1%, 5%, and 10% levels, respectively.

serial correlation test with statistics $Q_{12}(uh^{-1/2})$ and $Q_{12}(u^2h^{-1})$, the Engle and Ng (1993) SB, NSB, PSB, and joint tests. The test results indicate that there is no asymmetric effect in the standardized residuals, which indicates that the model specification is appropriate. In addition, when the parameter s is insignificant, we delete the influence of $\log \sigma_t^2$ in the mean equation and also the dummy variables whose coefficients are insignificant in the variance equation. The structural changes identified through the ICSS algorism for all countries are summarized in appendix B.

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cointegration relationship in the long-run in order to ensure the effective operation of monetary policy. Engle and Yoo (1987) and Lee (1994) argue that the error-correction term is a crucial factor to explain the conditional mean of the cointegration variables. Lee (1994) incorporated the error-correction term into the GARCH model and established the EC-GARCH model. In this paper, we expand this model by adding the error-correction term in the mean equation to construct the Error-Correction EGARCH in Mean (EC-EGARCH-M) model. Third, in view of the objectives of this article, our model has several important uses in evaluating the rates of retail interest rate changes to (1) analyze the expected and unexpected impacts of monetary policy, as well as the relative sizes of the multiplier, (2) assess the interest rate risk on the changes of retail interest rates, (3) test the adjustment speed of the error correction item in the analysis of rigidity adjustments of retail interest rates, and (4) test the leverage effect of interest rate increase and decrease in the variance equation.

TABLE 6.

The Estimation Results of the EC-EGARCH(1,1)-M Model

Country	HK				IND			
Interest rate model	D_HK		L_HK		D_IND		L_IND	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
a_0	0.006	0.513	−0.025	0.000	−0.255	0.421	−0.292	0.001
a_1	0.352	0.000			0.945	0.000		
a_6	0.143	0.000						
b_1			0.180	0.000			0.485	0.000
b_2			0.183	0.000			0.447	0.000
b_3			0.207	0.000			0.235	0.000
b_4							0.140	0.005
m_E	0.033	0.017	−0.116	0.112	−0.030	0.001	0.015	0.000
m_U	0.041	0.000	0.034	0.000	0.037	0.000	0.014	0.007
S	–	–	–	–	–	–	−0.032	0.001
η_1	−0.001	0.895	−0.031	0.002	−0.221	0.000	–	–
η_2	−0.038	0.080	−0.065	0.043	–	–	–	–
ω	−1.497	0.005	−1.815	0.000	0.770	0.000	−6.062	0.000
α	1.216	0.000	−1.000	0.000	0.601	0.000	0.740	0.000
γ	0.438	0.002	−0.764	0.000	0.223	0.000	−0.194	0.045
β	0.261	0.092	0.174	0.032	3.600	0.000	−0.188	0.006
Dummy variables (joint test)	27.80	0.000	103.2	0.000	445.8	0.000	371.9	0.000
$H0: \eta_1 = \eta_2$	5.611	0.017	1.483	0.223	–	–	–	–
$Q_{12}(uh^{-1/2})$	8.143	0.615	12.62	0.180	10.11	0.520	8.744	0.364
$Q_{12}(u^2h^{-1})$	8.014	0.627	13.16	0.214	11.82	0.377	3.222	0.920
SB		0.997		0.167		0.646		0.115
NSB		0.747		0.278		0.455		0.770
PSB		0.243		0.759		0.261		0.454
Joint		0.649		0.566		0.133		0.446
log L		81.37		137.09		−101.08		2.015

Note: Statistics $Q_{12}(uh^{-1/2})$ and $Q_{12}(u^2h^{-1})$ represent the 12-order Ljung-Box statistics of the standardized residuals and the squares of them, respectively. log L indicates the value of the maximum likelihood function. For the SB, NSB, and the PSB tests, we list the p-values of the t-statistics. For the joint test (Joint), we list the p-values of the Chi-square statistics.

TABLE 6—*Continued*

Country	JAP				KOA			
Interest rate model	D_JAP		L_JAP		D_KOA		L_KOA	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
a_0	-0.032	0.026	-0.005	0.399	-0.007	0.238	-0.014	0.000
a_1			0.339	0.000	0.166	0.000	0.144	0.000
a_2			0.253	0.000	0.128	0.007	0.150	0.000
a_3			0.281	0.000				
a_5			-0.247	0.000				
a_6			0.213	0.000				
m_E	0.201	0.000	0.073	0.000	0.001	0.749	0.0001	0.005
m_U	0.288	0.000	0.057	0.000	0.003	0.335	0.0004	0.000
S	–	–	–	–	–	–	-0.0007	0.000
η_1	–	–	–	–	–	–	-0.0007	0.000
η_2	–	–	–	–	–	–	-0.0006	0.000
ω	-7.564	0.000	-1.425	0.003	-3.056	0.000	-13.41	0.000
α	-0.107	0.331	0.524	0.000	-0.468	0.000	1.174	0.000
γ	-0.089	0.227	-0.209	0.012	-0.271	0.000	-0.058	0.100
β	-0.534	0.001	0.810	0.000	0.571	0.000	0.140	0.000
Dummy variables (joint test)	104.2	0.000	14.50	0.000	322.9	0.000	141729	0.000
$H0: \eta_1 = \eta_2$	–	–	–	–	–	–	0.205	0.650
$Q_{12}(uh^{-1/2})$	15.05	0.238	7.078	0.421	9.034	0.529	12.54	0.185
$Q_{12}(u^2h^{-1})$	4.123	0.966	14.17	0.116	1.509	0.999	13.91	0.177
SB		0.986		0.109		0.377		0.630
NSB		0.863		0.200		0.408		0.228
PSB		0.541		0.119		0.811		0.990
Joint		0.902		0.226		0.575		0.252
log L		435.4		598.12		226.5		330.2

Note: Statistics $Q_{12}(uh^{-1/2})$ and $Q_{12}(u^2h^{-1})$ represent the 12-order Ljung-Box statistics of the standardized residuals and the squares of them, respectively. log L indicates the value of the maximum likelihood function. For the SB, NSB, and the PSB tests, we list the p-values of the t-statistics. For the joint test (Joint), we list the p-values of the Chi-square statistics.

Here, we explain the parameters listed in Table 6; their implications are as follows: (1) whether MPE has a significant effect (parameters m_E), (2) whether MPU has a significant effect (parameters m_U), (3) whether the effect of the volatility $\log \sigma_t^2$ is significant (parameters s), (4) whether or not the leverage effect exists (parameters γ), and (5) whether there is adjustment rigidity in the retail interest rate (parameters η_1, η_2). In order to provide a comparative overview, the empirical findings are summarized in Table 7. As indicated in the 3rd and 4th column in Table 7, the markup

TABLE 6—*Continued*

Country	MAL				PHI			
Interest rate model	D_MAL		L_MAL		D_PHI		L_PHI	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
a_0	0.095	0.006	0.215	0.011	0.038	0.650	0.0004	0.995
a_1	0.348	0.000	−0.015	0.863			−0.340	0.000
a_2			0.181	0.004				
a_3			0.310	0.000			0.150	0.010
a_4	0.095	0.000	0.095	0.112				
a_5							0.101	0.070
m_E	−0.047	0.000	0.009	0.493	−0.007	0.663	0.074	0.000
m_U	0.089	0.000	0.047	0.004	0.046	0.005	0.053	0.002
S	0.019	0.000	0.032	0.010	0.326	0.000	0.355	0.030
η_1	−0.157	0.000	−0.036	0.008	−0.052	0.216	−0.018	0.679
η_2	−0.244	0.000	–	–	−0.104	0.000	−0.143	0.000
ω	−0.991	0.402	−3.425	0.002	0.310	0.069	0.008	0.938
α	0.805	0.000	0.465	0.000	0.065	0.359	0.013	0.895
γ	0.368	0.000	−0.075	0.368	0.048	0.300	0.246	0.009
β	0.561	0.000	0.354	0.126	−0.730	0.000	0.394	0.218
Dummy variables (joint test)	55.59	0.000	7.770	0.020	52.85	0.000	3.290	0.069
$H0 : \eta_1 = \eta_2$	11.27	0.000	–	–	1.098	0.294	7.591	0.005
$Q_{12}(uh^{-1/2})$	12.58	0.248	12.81	0.118	12.59	0.399	12.43	0.190
$Q_{12}(u^2h^{-1})$	13.17	0.214	7.529	0.481	6.229	0.904	13.92	0.125
SB		0.745		0.166		0.887		0.438
NSB		0.948		0.261		0.505		0.850
PSB		0.303		0.766		0.771		0.242
Joint		0.699		0.319		0.861		0.701
log L		185.61		240.7		−329.23		−315.43

Note: Statistics $Q_{12}(uh^{-1/2})$ and $Q_{12}(u^2h^{-1})$ represent the 12-order Ljung-Box statistics of the standardized residuals and the squares of them, respectively. log L indicates the value of the maximum likelihood function. For the SB, NSB, and the PSB tests, we list the p-values of the t-statistics. For the joint test (Joint), we list the p-values of the Chi-square statistics.

TABLE 6—*Continued*

Country	SIG				THA			
Interest rate model	D_SIG		L_SIG		D_THA		L_THA	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
a_0	−0.017	0.049	−0.027	0.000	−0.022	0.981	2.426	0.156
a_1					0.660	0.000	0.985	0.000
a_3	−0.921	0.000						
b_1					−0.501	0.003	−0.779	0.000
b_3	0.926	0.000						
b_5			−0.027	0.000				
m_E	0.018	0.000	0.001	0.500	0.0002	0.987	−0.038	0.012
m_U	0.013	0.000	0.003	0.044	−0.0001	0.991	0.020	0.208
S	−0.001	0.051	−0.002	0.000	–	–	0.079	0.058
η_1	–	–	−0.010	0.000	–	–	−0.241	0.000
η_2	–	–	−0.014	0.035	–	–	−0.227	0.000
ω	−5.731	0.000	−6.567	0.000	−1.796	0.000	1.919	0.011
α	0.873	0.000	0.514	0.000	−0.425	0.000	0.539	0.001
γ	0.375	0.000	−0.575	0.000	0.092	0.111	0.103	0.318
β	0.049	0.497	−0.107	0.176	0.656	0.000	0.370	0.032
Dummy variables (joint test)	372.4	0.000	211.44	0.000	207.86	0.000	13.80	0.000
$H0 : \eta_1 = \eta_2$	–	–	0.392	0.530	–	–	0.149	0.699
$Q_{12}(uh^{-1/2})$	6.919	0.646	11.48	0.460	8.713	0.464	5.315	0.802
$Q_{12}(u^2h^{-1})$	7.598	0.668	0.248	1.000	3.216	0.976	5.374	0.865
SB		0.953		0.108		0.161		0.183
NSB		0.814		0.382		0.891		0.862
PSB		0.407		0.988		0.488		0.825
Joint		0.847		0.430		0.514		0.577
log L		443.14		484.56		−4.455		−16.70

Note: Statistics $Q_{12}(uh^{-1/2})$ and $Q_{12}(u^2h^{-1})$ represent the 12-order Ljung-Box statistics of the standardized residuals and the squares of them, respectively. log L indicates the value of the maximum likelihood function. For the SB, NSB, and the PSB tests, we list the p-values of the t-statistics. For the joint test (Joint), we list the p-values of the Chi-square statistics.

TABLE 6—*Continued*

Country	TWN				US			
Interest rate model	D_TWN		L_TWN		D_US		L_US	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
a_0	−0.0007	0.039	−0.019	0.208	0.1000	0.000	0.002	0.380
a_1	−0.010	0.013			0.742	0.000		
a_2					0.238	0.000		
a_6	0.109	0.000						
b_1					−0.975	0.000	−0.326	0.000
b_2							−0.154	0.026
m_E	−0.00001	0.785	0.036	0.275	0.450	0.000	0.557	0.000
m_U	0.002	0.000	−0.029	0.405	0.889	0.000	0.783	0.000
S	–	–	–	–	0.019	0.000	–	–
η_1	−0.006	0.007	–	–	−0.848	0.000	−0.124	0.000
η_2	−0.010	0.013	–	–	–	–	0.001	0.875
ω	−9.634	0.000	−4.031	0.000	−8.518	0.000	−5.967	0.000
α	−1.218	0.000	0.404	0.013	0.097	0.453	0.149	0.226
γ	−1.111	0.000	−0.024	0.830	0.887	0.000	−0.051	0.610
β	−0.406	0.000	0.044	0.839	0.390	0.000	−0.626	0.000
Dummy variables (joint test)	701.22	0.000	14.25	0.000	34.54	0.000	180.22	0.000
$H0 : \eta_1 = \eta_2$	2.681	0.101	–	–	–	–	12.36	0.000
$Q_{12}(uh^{-1/2})$	11.94	0.289	9.718	0.641	1.348	0.998	8.858	0.354
$Q_{12}(u^2h^{-1})$	12.01	0.362	8.348	0.757	0.0007	1.000	3.120	0.978
SB		0.566		0.258		0.402		0.228
NSB		0.643		0.776		0.493		0.234
PSB		0.944		0.336		0.838		0.203
Joint		0.929		0.687		0.796		0.377
log L		781.12		23.76		322.52		337.62

Note: Statistics $Q_{12}(uh^{-1/2})$ and $Q_{12}(u^2h^{-1})$ represent the 12-order Ljung-Box statistics of the standardized residuals and the squares of them, respectively. log L indicates the value of the maximum likelihood function. For the SB, NSB, and the PSB tests, we list the p-values of the t-statistics. For the joint test (Joint), we list the p-values of the Chi-square statistics.

and incomplete pass-through effects exist in most countries. The 5th column indicates that most cointegration relations are asymmetric adjustment mechanisms from MTAR tests. The 6th and 7th column indicate that most impacts of MPE and MPU are positive and a few are negative, and the effect of MPU is larger that MPE. The 8th column indicates that the ratios of hetero-risk effect are significant approximately 50%, and some signs are positive and some negative. The 9th column indicates that 80% of the results prove the risk asymmetric effect, and only approximately 40% prove the leverage effect. Lastly, most countries have downward rigid adjustments in retail interest rate, as shown in the 10th column.

In order to understand the influences of MPE and MPU on the long-run multiplier, θ_{i1} in Table 7 is assumed to be a dependent variable to determine dummy variables when MPE and MPU coefficients are significantly positive, thereby enabling a testing of the influences of MPE and MPU on θ_{i1}. A regression equation is established as follows:

$$\theta_{i,1} = b_0 + b_1 D_{i,MPE} + b_2 D_{i,MPU} + \upsilon_i, \tag{7}$$

where D_{MPE} indicates that the dummy variable in Table 7 is 1 if the MPE coefficient in the deposit and lending rate equation is significantly positive, or 0 otherwise. D_{MPU} indicates that the dummy variable is 1 if the MPU coefficient in the deposit and lending rate equation is significantly positive; otherwise, it is 0, and υ_i is an error term. Since only 20 samples are used, in order to avoid the problem of a non-normal and small sample, 5000 bootstrap samples were used and five percentile intervals obtained—97.5%, 95.0%, 90.0%, 10.0%, 5.0%, and 2.5%. Table 8 lists the regression estimation results. The results indicate that the b_1 value within the confidence interval does not reject the null; this implies that MPE does not lead to an increase in the pass-through multiplier. On the other hand, if the b_2 value outside the confidence interval rejects the null, it implies that the MPU leads to an increase in the pass-through multiplier. Thus, only the MPU can increase the power of pass-through in the long run making it more effective.

TABLE 7.

Summary and Comparison of Estimation Results

Country	Model	Markup/Markdown (θ_0)	Pass through type (θ_1)	Pass-through mechanism (MTAR test)	Impact of MPE variance ($\hat{s}$)	Impact of MPU variance ($\hat{\gamma}$)	Asymmetry of the conditional ($\hat{\eta}_1, \hat{\eta}_2$)	Asymmetry of the conditional	Adjustment rigidity	long-run multiplier
HK	DI_HK	markdown	Incomplete	Asymmetric	Positive	Positive	–	Positive	Downward	0.846
	LI_HK	markup	Incomplete	Asymmetric	–	Positive	–	Negative (Leverage effect)	Downward	0.616
IND	DI_IND	markup	Incomplete	Symmetric	Negative	Positive	–	Positive	Error correction	0.477
	LI_IND	markup	Incomplete	–	Positive	Positive	Negative	Negative (Leverage effect)	–	0.029
JAP	DI_JAP	markup	Incomplete	–	Positive	Positive	–	–	–	0.489
	LI_JAP	markup	Incomplete	–	Positive	Positive	–	Negative (Leverage effect)	–	0.807
KOA	DI_KOA	markup	Incomplete	–	–	–	–	Negative (Leverage effect)	–	0.006
	LI_KOA	markup	Incomplete	Asymmetric	Positive	Positive	Negative	–	Upward	0.369
MAL	DI_MAL	markup	Incomplete	Asymmetric	Negative	Positive	Positive	Positive	Downward	0.870
	LI_MAL	markup	Incomplete	Symmetric	–	Positive	Positive	–	Error correction	0.605
PHI	DI_PHI	markup	Incomplete	Asymmetric	–	Positive	Positive	–	Downward	0.578
	LI_PHI	markup	Incomplete	Asymmetric	Positive	Positive	Positive	Positive	Downward	0.624
SIG	DI_SIG	markup	Incomplete	–	Positive	Positive	Negative	Positive	–	0.016
	LI_SIG	markup	Incomplete	Asymmetric	–	Positive	Negative	Negative (Leverage effect)	Downward	0.322
THA	DI_THA	markup	Incomplete	–	–	–	–	–	–	0.0002
	LI_THA	markup	Incomplete	Asymmetric	Negative	–	Positive	–	Upward	0.554
TWN	DI_TWN	markup	Incomplete	Asymmetric	–	Positive	–	Negative (Leverage effect)	Downward	0.217
	LI_TWN	markup	Incomplete	–	–	–	–	–	–	0.007
US	DI_US	–	Incomplete	Symmetric	Positive	Positive	Positive	Positive	Error correction	0.993
	LI_US	markup	Incomplete	Asymmetric	Positive	Positive	–	–	Upward	0.834

Note: This table be summarized form Tables 3, 4, and 6, the notation "–" implies the results are insignificant or not be estimate.

TABLE 8.

The Influences of MPE and MPU on the Long-Run Multiplier

Critical interval values	$H0 : b_1 = 0$	$H0 : b_2 = 0$
97.5% interval	0.269	0.341
95.0% interval	0.230	0.286
Coefficient value	**0.029**	**0.384**
5.0% interval	−0.224	−0.276
2.5% interval	−0.265	−0.334
Testing results	Not reject $H0$	Reject $H0$

Note: There are 5000 bootstrap samples were used and get five percentile intervals, which are 97.5%, 95.0%, 90.0%, 10.0%, 5.0%, and 2.5%. The bootstrap process had be adjustment by the Newey-West HAC Standard Errors & Covariance (lag truncation=2).

5. ECONOMIC MEANINGS AND IMPLICATIONS

The empirical findings are summarized as follows: (1) Except for Hong Kong, the markup effects in interest rate pricing exist in most countries. (2) Most cointegration relations are asymmetric, and only a few are symmetric. (3) Most impacts of MPE and MPU are positive, and the effect of MPU impulse is larger than expected. (4) The impacts of hetero-risk are significant in certain countries, and some signs are positive and some negative. (5) The leverage effect exists only in a few countries. (6) Most countries have downwards rigid adjustments in retail interest rate.

The economic significance of the above results is as follows: First, deposit rates are higher than the policy rate (i.e., the money market rate) in most countries, except Hong Kong, where the deposit rate is lower than the money market rate. The lending rate is higher than the policy rate in all countries. Second, in most sampled countries, the long-run relationship between bank retail interest rates and the policy rate to achieve stability must be considered in the context of asymmetric information; without it, the mechanism may not work. Third, when a nation's monetary policy is announced when the community least expects it, the policy is quite effective. On the other hand, if a monetary policy is expected, its effect will be rather muted. Fourth, the stable long-run equilibrium between retail interest rates and policy rate must consider asymmetric information. As far as the adjustments of retail interest rates are concerned, in most countries, rising rates are faster than falling rates. In other words, we find downward rigidity in retail rates.

Our results have many economically important features. This paper is an extension of the work on interest-rate pass-through and its validation by Kleimeier and Sander (2006). We have found that both expected and unexpected monetary policy interest rates have an influence on interest-rate pass-through in European Union countries. This paper considers the stickiness of interest rate adjustments and the impact of interest rate risks to examine interest-rate pass-through in Asian countries. A number of important yet interesting conclusions are drawn. First, the retail interest rates in most countries do not necessarily respond to the adjustments of policy interest rates. To reflect costs, the fixed markup is the common tool different countries use to reduce costs. Second, the mechanism to adjust market interest rates slows down when the magnitude of adjustments of retail interest rates is smaller than that of poly interest rates. At this juncture, there is a short-run spread between interest rates but a long-run sticky equilibrium in the monetary system. The equilibrium is caused by differing speeds of interest rate adjustments. Third, this paper finds that the impact of expected and unexpected monetary shocks is mostly positive, consistent with Kleimeier and Sander (2006). However, in contrast to Kleimeier and Sander (2006), this paper concludes that unexpected monetary shocks have a significantly greater effect than expected monetary shocks. This is perhaps due to a single currency in the European Union and required disclosure of monetary policies. As a result, it is difficult for banks from different countries to collude. However, Asian countries do not have a common currency and lack full information about one another's policies. In economic blocks without monetary integration, the authorities of different countries have a difficult time communicating effectively. Therefore, it is difficult to integrate economically. Fourth, consistent with Kleimeier and Sander (2006), this paper argues that banks in the sampled countries exhibit asymmetric pricing behavior among themselves. This shows that the banking systems of different countries are in imperfect competition. However, in contrast to Kleimeier and Sander (2006), the impact of non-anticipated monetary shock is greater than that of anticipated monetary shocks, and therefore, lending interest rates are more sluggish than deposit interest rates. Finally, as far as adjustments of retail interest rates are concerned, in most countries, rising rates are faster than falling rates. In other words, retail rates show downward rigidity. This causes varying costs and benefits created by interest rate risks to banks in different countries. The information that monetary authorities are using expansion (i.e., downward policy interest rates) or contraction (i.e., upward policy interest rates) policies has little difference in regard to its effects.

Table 6 and Table 8 show a number of surprising findings. The empirical results indicate that, in most sampled countries, the influence of MPU is greater than that of MPE. In other words, when monetary policies are expected, the multipliers can be passed through, and the policies are therefore less efficient. In contrast, when the policies are not expected, the multipliers can be boosted, and the policies become more efficient. The results indicate that only when the shock of monetary policies is not anticipated can they enhance pass-through capabilities over the long run and become more effective. This conclusion is contrary to the findings of Kleimeier and Sander (2006) that the shocks of anticipated and non-anticipated monetary policies influence pass-through of interest rates in EU countries in exactly the opposite way. However, the empirical result of this study shows that the multipliers of retail interest rate shocks are different for expected and unexpected monetary policies. When the monetary policies are anticipated, the pass-through adjustment of lending interest rates is faster than that of deposit interest rates. This paper infers that the sampled countries in Kleimeier and Sander (2006) may have a common currency. They have full information, and the transparency of monetary policies is high. However, the sampled countries in this study do not have such characteristics. The above results are representative of the effects of monetary policy shocks in two different monetary systems. With no previous studies addressing this issue, such findings have been obtained for the first time in this work.

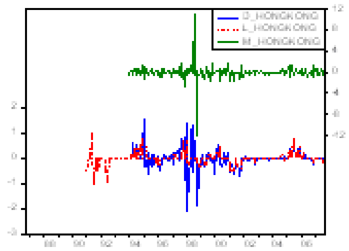
From the empirical results, interest rate pass-through in the different Asian countries is different. The possible causes of this are as follows: the first is the volatility of interest rates; the second is the systems and current situation of the banks in these countries. Figure 1 illustrates the fluctuation of the interest rates in ten countries. The left axis measures the fluctuation of the deposit and the lending interest rates, and right axis measures that of the monetary policy rate. For the three interest rates, the fluctuation is higher in Indonesia and Thailand, being over 7%, while that of monetary policy rate is higher in Indonesia, Philippines, and Thailand, being over 10%. Generally speaking, except for Taiwan, the fluctuation of deposit interest rates in other countries was higher than that of lending interest rates during the study period. The higher the fluctuation of interest rates, the greater are the interest rate risks, uncertainty, and impacts of unexpected monetary policies.

In addition, we utilized the data on Bank Regulation and Supervision, collected from the World Bank Finance Research Datasets, to complete the characteristics of six indices including Entry into Banking, Ownership, Capital, Internal Management/Organizational Requirements, Liquidity & Diversification Requirements, and Supervision. These are shown in Table 9.[9] We have discussed, in this illustration, the causes of the differences between the countries. In the first index of Entry into Banking, we find

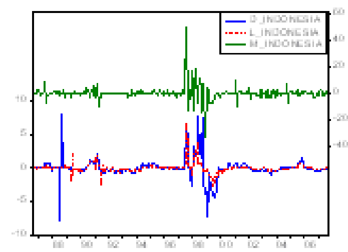
[9]This paper only extracted data on Bank Regulation and Supervision from the World Bank Finance Research Datasets to interpret six indices of twelve indices. The reader can obtain more details by visiting the following website:
http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,
contentMDK:20345037 ~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html.

that in these countries, the central bank or a relevant supervision agency is the body/agency that grants commercial banking licenses. In the U.S., each state is allowed the right to approve the establishment of banks. For the second index, Ownership, in the five countries, Malaysia, Philippines, Korea, Taiwan, and Thailand, there is a maximum percentage of bank capital that can be owned by a single owner. With regard to the degree of concentration of bank capital, 62.30% of the bank capital is owned by financial conglomerates in Taiwan, by three banks in Thailand, and by one bank in the U.S. In Malaysia, all banking institutions are private enterprises and are listed or owned by listed entities. In addition, the percentage of commercial banks in this country (deposits were held by the five largest banks at Year End 2005), in the U.S. and Taiwan is between 30% and 40%; additionally, the ratio is greater than 50% in five countries, and is the highest in Thailand (64.0%). In the third index, Capital, the minimum Capital to Asset Ratio requirements are all between 8 % $\sim$ 10%, and the fraction of the banking systems' deposits and loans are in banks that are 50% or more government-owned as of Year End 2005. The ratios in Hong Kong, Singapore, Malaysia, and the United States are zero; the ratio in Indonesia is 0.38. Of the fraction of the banking systems' deposits and loans that are in banks that are 50% or more foreign-owned as of year-end 2005, Korea has the maximum fraction, and Taiwan has the minimum fraction. The fourth index indicates that the supervisory authority in most countries forces banks to change their internal organizational structure. In the fifth index, Liquidity & Diversification Requirements, except for Singapore, Thailand, and the U.S., other countries' banks are required to have some minimum diversification of loans among sectors, or to have sectoral concentration limits. Only in Japan, banks are not limited in their lending to single or related borrowers. Banks in Hong Kong, Philippines, Singapore, Malaysia, and Taiwan are limited in their sectoral concentration. Except for in Hong Kong, banks are required to hold either liquidity reserves or any deposits at the Central Bank. The sixth index shows that, except for Japan, the Central Bank supervises banks.

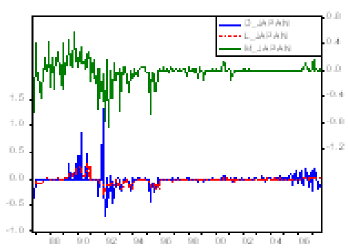
From the above, we use Japan as examples. In Table 7, the short-run adjustment mechanism of deposit and lending interest rate do not exist. Based on Table 9, the Japan's bank capital is not concentrated in a few banks, and the fraction of the banking systems' deposits that are in foreign-owned banks is lower. Banks are not limited in their lending to single or related borrowers or sectoral concentration, and the central bank does not supervise banks. For Taiwan, according to the results of Table 6, the impacts of MPE_{it} and MPU_{it} in the lending interest-rate models are not significant, and the great difference is that financial conglomerates own 62.30% of Taiwan bank capital. For the U.S., the results of Table 3 show that the parameters of interest rate pass-through of deposit and lending rate are higher. The results of Table 6 indicate that the impacts of MPE_{it} and MPU_{it} are greater than in the other nine Asian countries. The inferred causes, apart from geological separation, are high U.S. financial deregulation, high competition among banks, and low concentration. Further, an important factor is that the U.S. has the most bank supervisors. Generally speaking, the central bank's supervision and management of banks can easily ensure the efficiency of implementing monetary policies, and can promote the existence of the interest rate pass-through mechanism.



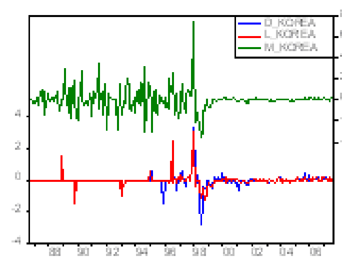
Hong Kong



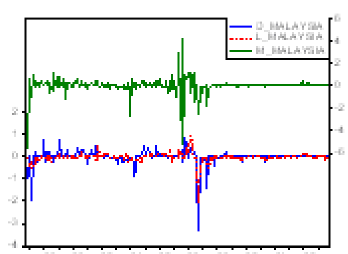
Indonesia



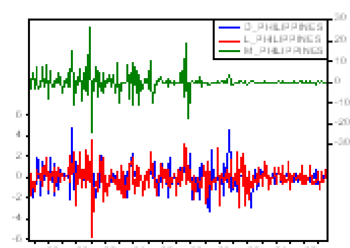
Japan



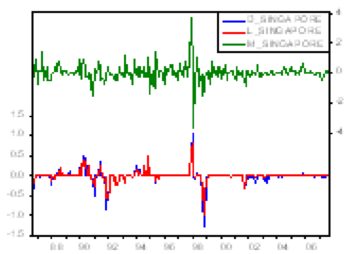
Korea



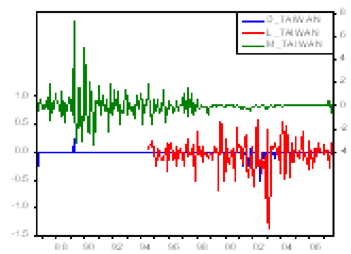
Malaysia



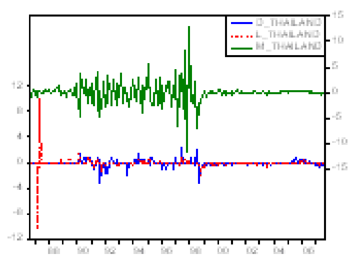
Philippines



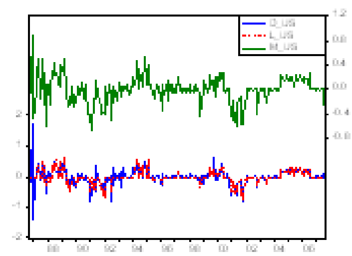
Singapore



Taiwan



Thailand



U.S.

FIG. 1. The Fluctuation of the Interest Rates in 10 Countries
(Note: D_i denotes the deposit interest rate of country i; L_i indicates the lending rate of country i; and M_i is the money market rate of country i)

TABLE 9.

Bank Regulation and Supervision

Country	Hong Kong	Indonesia	Japan	Malaysia	Philippines	Singapore	Korea	Taiwan	Thailand	United States
1. Entry into Banking										
The body/agency grants commercial banking licenses	Hong Kong Monetary Authority	Bank Indonesia, the Central Bank of Republic //Indonesia	Financial Services Agency	Minister of Finance (MoF) on recommendation of //Bank Negara Malaysia (BNM The Central Bank of //Malaysia)	Not Available	Monetary Authority of Singapore(MAS)	FSC (Financial Supervisory Commission	Financial Supervisory Commission	Ministry of Finance by Recommendation of Bank of //Thailand	Office of the Comptroller of the Currency (OCC) and Individual States
2. Ownership										
There is a maximum percentage of bank capital that can be owned by a single owner	No	No	No	Yes	Yes	No	Yes	Yes	Yes	No
A fraction of capital in the largest 10 banks (in terms of their domestic assets) is owned by commercial/industrial and/or financial conglomerates? If there are fewer than 10 banks, use that number in your answer.	Not Available	0.1056	Not Available	All banking institutions are private enterprises, are listed or owned by listed entities	Not Available	Not Available	0	62.30% by financial conglomerates	3 banks	1
The percentage of commercial banks in this country (deposits held by the five largest banks at Year End 2005)	Not Available	0.5194	0.443	0.569	0.514	Not Available	0.688	0.3303	0.649	0.39

TABLE 9—*Continued*

Country	Hong Kong	Indonesia	Japan	Malaysia	Philippines	Singapore	Korea	Taiwan	Thailand	United States
3. Capital										
The minimum Capital to Asset Ratio requirement	0.08	0.08	8% (for internationally active banks)	0.08	0.1	0.1	Not Available	0.08	0.085	0.08
The fraction of the banking systems' deposits are in banks that are: 50% or more **government** owned as of year-end 2005	0	0.3825	Not Available	0	0.099	0	0.0907	0.1441	0.161	0
The fraction of the banking systems' deposits are in banks that are: 50% or more **foreign** owned as of year-end 2005	Not Available	0.3859	0.03	0.205	0.117	$> 50\%$	0.6872	0	0.039	0.081
The fraction of the banking systems loans are in banks that are: 50% or more government owned as of year-end 2005	0	0.3919	Not Available	0	0.123	0	0.1425	0.1791	0.164	0
The fraction of the banking systems loans are in banks that are: 50% or more foreign owned as of year-end 2005	Not Available	0.3832	0.016	0.203	0.134	$> 50\%$	0.5761	0	0.045	0.082
4. Internal Management/ Organizational Requirements										
The supervisory authority forces a bank to change its internal organizational structure	Yes	Yes	Yes	Yes	Not Available	Yes	Yes	Yes	Yes	Yes

TABLE 9—*Continued*

Country	Hong Kong	Indonesia	Japan	Malaysia	Philippines	Singapore	Korea	Taiwan	Thailand	United States
5. Liquidity & Diversification Requirements										
Banks are required to have some minimum diversification of loans among sectors, or they have sectoral concentration limits	Yes	Yes	Yes	Yes	Yes	Not Available	Yes	Yes	No	No
Banks are limited in their lending to single or related borrowers	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Banks are limited in their sectoral concentration.	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No
Banks are required to hold either liquidity reserves or any deposits at the Central Bank	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Supervision										
Central Bank supervises banks	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total number of professional bank supervisors	131	Not Available	450	231	Not Available	Around 120	142	More than 1, 600 (including FSC, Central Bank and Central Deposit Insurance Company)	380	2218

Note: This paper only extracted data on Bank Regulation and Supervision from World Bank Finance Research Datasets to interpret six indices of 12 indices. The reader can obtain more detail by visiting the following website: http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20345037~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html.

6. CONCLUSION

In terms of research motives, we utilize the asymmetric threshold cointegration test and the EC-EGARCH (1, 1)-M model in order to investigate the impact of interest rate fluctuation (risk) on the deposit and lending rates; under forward-looking assumptions, the impacts of the monetary policy are divided into two—expected and unexpected. Further, this paper also considers that the interest rate pass-through and adjustment mechanism may fluctuate asymmetrically and heterogeneously, or adjust rigidly; as compared with pre-existing documents, this is a more in-depth and novel study. This research has made the following academic and political contributions. First, by analyzing the pass-through mechanism of the retail interest rate in the United States and Asian countries, we were able to understand the interest rate pricing behavior in these countries, which in turn, helps investors who need to borrow or lend internationally understand the costs and revenue associated with funds. Second, our empirical results suggest that market information enables the asymmetric adjustment processes and the diversity of the speed of the interest rate pass-through mechanism. When the central bank implements the monetary policy, it must pay close attention to the impacts of the market information on the retail interest rates and to their pricing. Third, our findings could be a reference for those investors and commercial banks interested in investing in Asian countries, and to the financial or monetary authorities that need to evaluate or recommend policies. Fourth, our empirical methods and models are new to the field and we obtain numerous new and useful findings. Our methodology and results could serve as a basis for future studies.

APPENDIX A

Introduction of the Threshold Cointegration Test

Before conducting the time-series analysis, the first thing to do is to confirm the stationary of all variables. When each variable is $I(1)$ and there exists at least one long-run stationary relationship, then there is the cointegration relation among all variables. The Engle and Granger (1987) test is to examine the linear cointegration relation. Enders and Siklos (2001) argue that cointegration relation may not be symmetric and they propose a test to examine the asymmetric cointegration relation. In this paper, we employ the TAR and MTAR model suggested by Enders and Siklos (2001) to ensure the asymmetric long-run cointegration relation.

Assume the ranks of variables $\{y_{1t}, \ldots, y_{nt}\}$ are $I(1)$. According to the assumptions of Engle and Granger (1987) cointegration test, the long-run relation among the variables is:

$$y_{1t} = \widehat{\beta}_0 + \widehat{\beta}_1\, y_{2t} + \cdots + \widehat{\beta}_n\, y_{nt} + e_t. \qquad \text{(A.1)}$$

where $\hat{\beta}_i$ is the parameter to be estimated; e_t is the error term, and when the long-run relation exists, e_t is a time series. To confirm the cointegration relation, we use the following equation to conduct the unit-root test:

$$\Delta e_t = \rho e_{t-1} + \varepsilon_t. \qquad \text{(A.2)}$$

where ε_t follows a white noise process; when $-2 < \rho < 0$, there exist the symmetric long-run equilibrium relation. In the symmetric model, no matter e_{t-1} is positive or negative, the changes of the value of e_t equals ρ times e_{t-1}. However, if the long-run equilibrium is asymmetric, then the use of equation (A.1) would cause the misspecification problem. Enders and Granger (1998) and Enders and Siklos (2001) assume that the asymmetric adjustments come from the positive and negative values of the long-run error. In this study, we establish the threshold autoregressive model to examine the existence of the asymmetric long-run equilibrium relation (cointegration). Our model is as follows:

$$\Delta e_t = I_t \rho_1 e_{t-1} + (1 - I_t)\rho_2 e_{t-1} + \varepsilon_t. \qquad \text{(A.3)}$$

where I_t is an indicator variable and is specified as

$$I_t = \begin{cases} 1 & \text{if} e_{t-1} \geq \tau \\ 0 & \text{if} e_{t-1} < \tau \end{cases}. \qquad \text{(A.4)}$$

Equation (A.4) says that when e_{t-1} is greater than or equal to the threshold value τ, the adjustment coefficient is ρ_1 and the adjustment margin equals $\rho_1 e_{t-1}$. When e_{t-1} is less than τ, the adjustment coefficient is ρ_2 and the adjustment margin equals $\rho_2 e_{t-1}$.

Since the true characteristics of the nonlinear model remain unknown, Enders and Siklos (2001) assume that Δe_{t-1}, the first-order differenced value of e_{t-1}, could represent the momentum of the interest rate adjustment and reveal the asymmetric adjustment of the interest rate. This asymmetric TAR model is the so-called Momentum-TAR (MTAR) model and is specified as follows:

$$\Delta e_t = M_t \rho_1 e_{t-1} + (1 - M_t)\rho_2 e_{t-1} + \varepsilon_t. \qquad \text{(A.5)}$$

where the indicator variable M_t is defined as

$$M_t = \begin{cases} 1 & \text{if} \Delta e_{t-1} \geq \tau \\ 0 & \text{if} \Delta e_{t-1} < \tau \end{cases}. \qquad \text{(A.6)}$$

Equation (A.6) says that when Δe_{t-1} is greater than or equal to the threshold value τ, the adjustment coefficient is ρ_1 and the adjustment margin equals $\rho_1 e_{t-1}$. When Δe_{t-1} is less than τ, the adjustment coefficient is ρ_2 and the adjustment margin equals $\rho_2 e_{t-1}$.

In addition, if there exists autocorrelation relation between equations (A.3) and (A.5), then the TAR and MTAR models should be revised as:

$$\Delta e_t = I_t \rho_1 e_{t-1} + (1 - I_t)\rho_2 e_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta e_{t-j} + \varepsilon_t. \qquad \text{(A.7)}$$

$$\Delta e_t = M_t \rho_1 e_{t-1} + (1 - M_t)\rho_2 e_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta e_{t-j} + \varepsilon_t \qquad \text{(A.8)}$$

No matter the chosen model is equation (A.7) or equation (A.8), the sufficient condition for series $\{e_t\}$ to be stationary is $-2 < (\rho_1, \rho_2) < 0$. Under the circumstance that $\{e_t\}$ is stationary and the threshold value is known, the OLS estimators of ρ_1 and ρ_2 are consistent estimators following asymptotic multivariate normal distribution.

Enders and Siklos (2001) employ the Φ statistic to examine the existence of the asymmetric cointegration relation. The null hypothesis is $\rho_1 = \rho_2 = 0$ and statistic Φ follows the F-distribution. A rejection of the null hypothesis indicates that the cointegration relation exists. In this case, one could test the existence of the symmetric adjustment with the null hypothesis specified as $\rho_1 = \rho_2$. If the null hypothesis of symmetric adjustment could not be rejected, this indicates the existence of the symmetric long-run relation suggested by Engle-Granger cointegration. If the null hypothesis ($\rho_1 = \rho_2$) is rejected, this means that there exist the asymmetric long-run cointegration relation among the interest rates.

In addition, we take advantage of the method suggested by Chan (1993) to estimate the threshold value τ in the TAR and MTAR models. Let us use $\{y^j\}$ to represent our series, $j = 1, \ldots, T$. We first ascend the elements of series $\{y^j\}$ in the way that $y^1 < y^2 < \cdots < y^T$. For each y^j, we assign $\tau = y^j$. We keep the middle 70% of the observations and discard the first and last 15% of the observations. In this way, we could make sure that the observations we use to estimate the threshold value are appropriate ones.[1] Then we repeatedly estimate the model using OLS and employ

[1] When searching for the optimum threshold value, one has to ascertain that the models within the regimes could satisfy some of the statistic conditions, such as the degree of freedom, so that the estimation could work. The searching process starts from the smallest threshold value to the largest threshold value. We use monthly data in this study. To satisfy the degree of freedom condition, we discard the smallest and largest 15% of the observations and used the observations in the 15% to 85% range. Wane et al. (2004) use the same technique.

the grid search method to find the minimum of all the sum of squared errors from the OLS estimations. The threshold value corresponding to the minimum sum of squared error is the optimum threshold value. The optimum threshold value combined with the indicator variables will be utilized for the cointegration test. The critical value is adopted from the simulation results of Wane *et al.* (2004).

If the cointegration relation exists among the interest rates, then we must establish the error correction model to get a better estimation result. On the other hand, if there exists the heteroskedastic variance problem, then the traditional error-correction model may lead to a biased estimation results. To deal with this issue, we employ the EC-EGARCH-M model.

APPENDIX B

The Time of Structural Changes in 10 Countries (year/month)

Country	Deposit interest rate	Lending interest rate
Hong Kong	1995/05 1997/11 1998/11	1995/04 1997/10 2001/12 2005/03 2006/01
Indonesia	1988/09 1997/08 1999/11	1987/06 1987/09 1989/05 1991/08 1994/05 1997/08 1999/10
Japan	1989/11 1990/05 1991/11 1992/03 1995/10 2005/07	1991/01 1996/01
Korea	1993/01 199304 1995/12 1997/12 1998/09 2001/11 2005/09 2006/01	1988/12 1989/12 1993/01 1993/04 1996/07 1999/01

Country	Deposit interest rate	Lending interest rate
Malaysia	1987/04 1998/08 1999/05	1997/11 1999/06
The Philippines	2001/02	200203
Singapore	1990/01 1992/03 1994/01 1994/12 1997/12 1999/01 2001/09 2003/06	1990/02 1992/03 1994/08 1994/12 1995/09 1997/12 1999/01 2001/11
Thailand	1990/03 1992/05 1998/07 1999/01 2002/03 2005/05	1987/06
Taiwan	1989/05 2001/04 2002/12	2004/10 1999/08
U.S.	1987/02 1992/10 1999/11 2002/01	1992/02 1994/04 1995/03 1996/03 1998/10 2001/01 2002/01

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